

MEMORANDUM

Date: 09/26/01

To: H. Kahnhauser

From: A.J. Stevens

Subj.: RHIC ASE as a Function of Ion Species

As you are no doubt aware, the RHIC ASE¹ specifies limits on the total beam in the RHIC rings for Au and for protons; the former being *the equivalent of* 2.4×10^{11} Au ions at 100 GeV/u per ring, and the latter 2.4×10^{11} protons at 250 GeV per ring.

The total kinetic energy per ring, 4.8×10^{15} GeV for Au and 6.0×10^{15} for protons, is essentially the same, and it is this quantity which determines radiological consequences.^{2,3} Table 1 below gives the equivalent beam/energy per ring as a function of representative ion species.

Table 1. Representative Ion Species in RHIC

Species	Ions per Ring*	Kinetic Energy (GeV/u)
Deuterium (A=2)	1.2×10^{13}	125
Oxygen (A=16)	2.0×10^{12}	125
Silicon (A=28)	1.34×10^{12}	125
Copper (A=63)	6.48×10^{11}	115
Iodine (A=127)	3.60×10^{11}	104

*120 bunches per ring

The total GeV per ring for oxygen through iodine in Table 1 is between 4.0×10^{15} and 4.7×10^{15} . Deuterium (half of protons at 3.0×10^{15} GeV/ring) is lower than protons by a factor of 2. This is a 'special case' because of the potential for relatively high prompt radiation from deuterons in the Tandem-To-Booster line.

Please note that the C-A Department Radiation Safety Committee must consider each new species prior to its being introduced into RHIC. Beam limits for specific ions shall be proscribed in terms of beam energy and total number of ions in the RHIC rings before operations with the specific ion. These limits shall be set in writing by the RSC and must meet the beam and energy requirements in Ref. [1]. In part this is because the difficulty of *meeting* the ASE may differ by ion species, and in part because it may be convenient to modify either the number of ions or their highest energy as long as the total KE in the ASE is not violated. In any event, the total KE per ring for protons shall not exceed 6.0×10^{15} GeV, for deuterons 3.0×10^{15} GeV,

and for any ion heavier than deuterons 4.8×10^{15} until and unless a formal change in the ASE would be made and approved by the Laboratory and the DOE.

References/Footnotes

1. Accelerator Safety Envelope, Relativistic Heavy Ion Collider, Rev. 1, August 30, 1999, Sections 3.1 and 3.2
2. This statement is admittedly simplistic. The radiological consequences are also dependent on the fill period and loss patterns which are in principle dependent on ion species. However, the fill period is expected to be longer for lighter ions, not shorter. To date, losses are dominated by characteristics of the acceleration cycle (e.g. crossing transition cleanly and keeping the tune away from resonances during acceleration) that are also expected to be no worse for lighter ions.
3. Fortunately for radiological consequences, but unfortunately for the RHIC users, the RHIC detectors have components which are very sensitive to beam loss. For this reason, controlling beam loss has been, and will continue to be, a very high priority for the accelerator physics group supporting RHIC operations. I myself keep in contact with this topic via weekly meetings with Leif Ahrens.

Cc

D. Beavis
E. Lessard